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WITNESS my hand this
Twelfth day of November 2004

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Patents Act 1990

PROVISIONAL SPECIFICATION

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INVENTION TITLE: **Miniature wireless sensor device**

Miniature wireless sensor device

TECHNICAL FIELD

This invention relates to the wireless devices (also known as motes or smart dust).

More particularly this invention relates to the micropower source for these devices.

BACKGROUND TO THE INVENTION

A mote typically comprises the following subsystems:

- Sensing subsystem
- Data processing
- Data transmission/reception
- Micropower

The sensing subsystem is for monitoring the mote environment (light, motion, UV-radiation, dangerous chemicals, radioactivity, sounds, temperature, biological warfare, etc.). This element converts a physical value subject of monitoring into a modulated electrical signal.

The data processing subsystem processes information coded in the modulated electrical signal and converts it commonly to digital format. This information is further transmitted by the transmission system to the nearest other mote or directly to the base. From time to time the base sends commands to the mote. The command may, for example, request the mote to terminate any transmission, or to transmit current status immediately.

All the subsystems described above require a power source for their operation. There are examples of micropower

sources based on electrochemical energy storage (batteries) and on a photovoltaic element for continuous charging of the battery. Energy requirements are the main limitation in designs of small motes.

In addition, the motes and their photovoltaic elements are realized in substantially flat structures. This affects aerodynamic properties of these devices and their visibility.

OBJECTIVES OF THE INVENTION

It is therefore an object of the present invention to provide a wireless miniature sensing device with improved properties.

SUMMARY OF THE INVENTION

The invention provides for the subsystems of a mote to be to be formed within a curved sealed envelope.

The envelope is commonly of a spherical type, however, it may be advantageous to implement other shapes, selected based on their aerodynamic properties and/or visibility.

According to one aspect of the invention, a thin film photovoltaic device is utilizing a surface of the envelope shape as a substrate.

In one embodiment, at least part of the envelope is optically transparent and the said photovoltaic device is formed on internal surface of the envelope.

In another embodiment, the said photovoltaic device is formed on external surface of the envelope.

In further embodiment according to this aspect of the invention, some layers of the said thin film photovoltaic device are formed on internal surface of the said envelope, whereas other layers are formed on external surface of the envelope.

Although, this specification describes shape of the envelope as spherical, the invention is not limited to geometrical spheres, but provides for other, substantially curved and not necessary regular shapes and/or sections or partitions of the sphere.

The invention provides for envelopes to be made of glass, plastic, metals or any other suitable materials.

Although, the invention describes a photovoltaic element of thin film type, it is beneficial to utilize some specific thin film technologies such as organic PV (OPV), dye solar cells (DSC), Si, CdTe or ICS solar cells.

From one aspect of invention the said envelope comprises spherical electrically conductive core, on which layers of the PV cell are sequentially deposited. The top, electrically conductive layer comprise any of known transparent electrically conductive materials including, but not limited to
Transparent conducting oxides,
Conducting polymers,
Mesh made of conducting fiber.

The invention provides for a hole to be made in the envelope to enable external electrical connection(s) to the device. In one example these connections are made to antenna required for transmission/reception of information.

In one embodiment the conducting coating is extended to coat all or part of the internal surfaces of said hole(s) and provide said external electrical connection(s) and whereby said hole(s) are filled with the same or a second electrically conductive material or non-conducting material (e.g. ceramic glaze), forming a bond with said conducting coating and sealing said hole(s);

In another embodiment the said antenna is formed on internal or external surface of the envelope by isolating regions of the said electrically conductive material into appropriate shapes.

In yet, another embodiment the antenna is a wire extended to outside of the envelope or attached to the external surface of the envelope.

This invention provides for electrical connections to be made to said electrically conductive coating (including TEC) and/or to said electrically conductive material (ECM) via holes in one or both of the substrates, thereby eliminating the need for said electrically conductive coating and/or said electrically conductive material to penetrate the hermetic seal of RPEC cells and modules.

One layer of the said device comprises semiconductor. For wide band gap semiconducting materials invention provides

for photosensitization by dye, to absorb electromagnetic energy of light. It is preferably to utilise nano-dispersed semiconductors, thereby significantly increasing photoactive area of a cell.

In one embodiment layers of a cell are formed on internal surface of transparent spherical shape. The shape being made of glass, polymer or any other material transparent to the part of electromagnetic radiation that is absorbed by either dye when photoactive material comprise a dye attached to a semiconductor or just by semiconductor in absence of dye. Depending on application the part of the electromagnetic radiation comprise UV light, visible light, IR light or any combination thereof.

The invention also provides for using an internal space of a spherical device as an additional reservoir for electrolyte and drying agents. Additional electrolyte will extend useful life of the device by replacing lost or damaged electrolyte layer adjacent to the semiconducting layer. The semiconducting layer may or may not be covered by dye.

According to another aspect of the invention the mote is formed inside a spherical glass envelope (glass globe) Internal surface of the globe is completely or partially coated by the transparent electronic conductor. Some regions of the transparent electronic conductor form a substrate for a thin film photovoltaic device.

Additionally an energy storage device is formed inside the envelope. The energy storage device is either a high

capacity capacitor or an electrochemical battery or a combination thereof.

The invention provides for a thin energy storage device. The thin energy storage device is commonly formed to be adjacent to the thin film photovoltaic device. In some cases, however, the said thin energy storage device is formed on the separate part of internal or external surfaces of the envelope.

The said energy storage device and said photovoltaic device are electrically connected. It is found to be beneficial to place a diode in electrical circuit between these devices. The invention provides for thin film diode formed between the photovoltaic device and energy storage device. In some cases the layers of the said thin film diode cover substantially whole are of the photovoltaic device.

The invention also provides for conventional miniature energy storage device to be secured inside the said envelope.

In addition, the data processing and data reception/transmission subsystem are secured inside the envelope and electrically connected to the said energy storage device.

Position of the sensing subsystem in respect to the envelope depends on requirements of selected application. For light sensing, the photovoltaic cell itself provides an electrical signal modulated in accordance with light intensity.

For some applications (such as chemical and biological monitoring) the sensing subsystem is placed outside the

envelope. The invention provides for thin film sensors formed on external surface of the envelope.

To protect from mechanical impact the envelope is additionally enclosed in the rubbery type cover (e.g. polyurethane). For attaching to the various surfaces a layer of adhesive is created.

The motes of this type can be precisely delivered to a target position by accelerating a mote in a predetermined direction in such a way that after flying certain distance the mote will be in contact with the target object and adhesive will provide for the mote to remain in this position for a required length of time. The said acceleration may be given to a mote from a ground point or from the flying object (e.g. aircraft, helicopter).

Alternative the mote can be just dropped from a flying object. In this case height and speed of the flying object are taken into account to determine when to drop the mote in order for it to lend on predetermined surface.

The predetermined surface may belong to the moving ground object (e.g. car) or to a flying object.

In one embodiment the acceleration of a mote is achieved in a device similar to the air rifle, where a pressure force of compressed air accelerate the mote to a certain speed in a certain direction. The direction and magnitude of speed are selected in such way that projectile of the flying mote intersects surface of a target object.

BRIEF DESCRIPTION OF DRAWINGS

Having broadly portrayed the nature of the present invention, embodiments thereof will now be described by way of example and illustration only. In the following description, reference will be made to the accompanying drawings in which:

Figure 1 is a functional diagram of a mote formed in accordance with first example of the invention

Figure 2 is an enlarged section of a spherical mote formed in accordance with second example of the invention.

Figure 3 is an enlarged section of a spherical mote formed in accordance with third example of the invention.

Detailed description of drawings.

Referring to Fig.1 a mote comprises the following subsystems (elements):

- Sensing 1
- Data processing 2
- Data reception 7
- Data transmission 6
- Photovoltaic 5
- Energy storage 4, and
- Interfacing 3.

The photovoltaic, energy storage and interfacing subsystems are combined in the micropower block 9.

The mote according to this example operates as follows:

The DSC element converts light energy (yellow pen) into electricity (red pen), that is subsequently stored in the energy storage element. The interface conditions an electrical output of the energy storage element to satisfy the requirements of the sensor, data processing, data transmission and data reception subsystems.

The sensor converts a physical value (e.g. temperature, illumination, pressure, etc.- blue pen) into an information signal (red pen), which is processed by the data processing subsystem in accordance with a command (aqua pen) received from internet; the processed information is further transmitted by the data transmission block.

Referring to Fig. 2 a mote is build inside a spherical envelope 10, on internal surface of which thin film photovoltaic device 11, diode 12 and energy storage device 13 are subsequently formed. A part of the internal surface is allocated for the antenna 14. An electronic block 15 that comprises remaining subsystems of the mote is inserted into the sphere though an opening 16 and electrically connected to the energy storage element and to antenna using wires 17. The remaining space inside the sphere is filled with a filler 18 (good heat conductor) and the opening is blocked by a stopper 19.

Referring to Fig. 3 a spherical envelope 20 is coated by a rubbery material 21, external surface 22 of which made adhesive. The antenna 23 is extended from inside the envelope and secured by the rubbery layer.

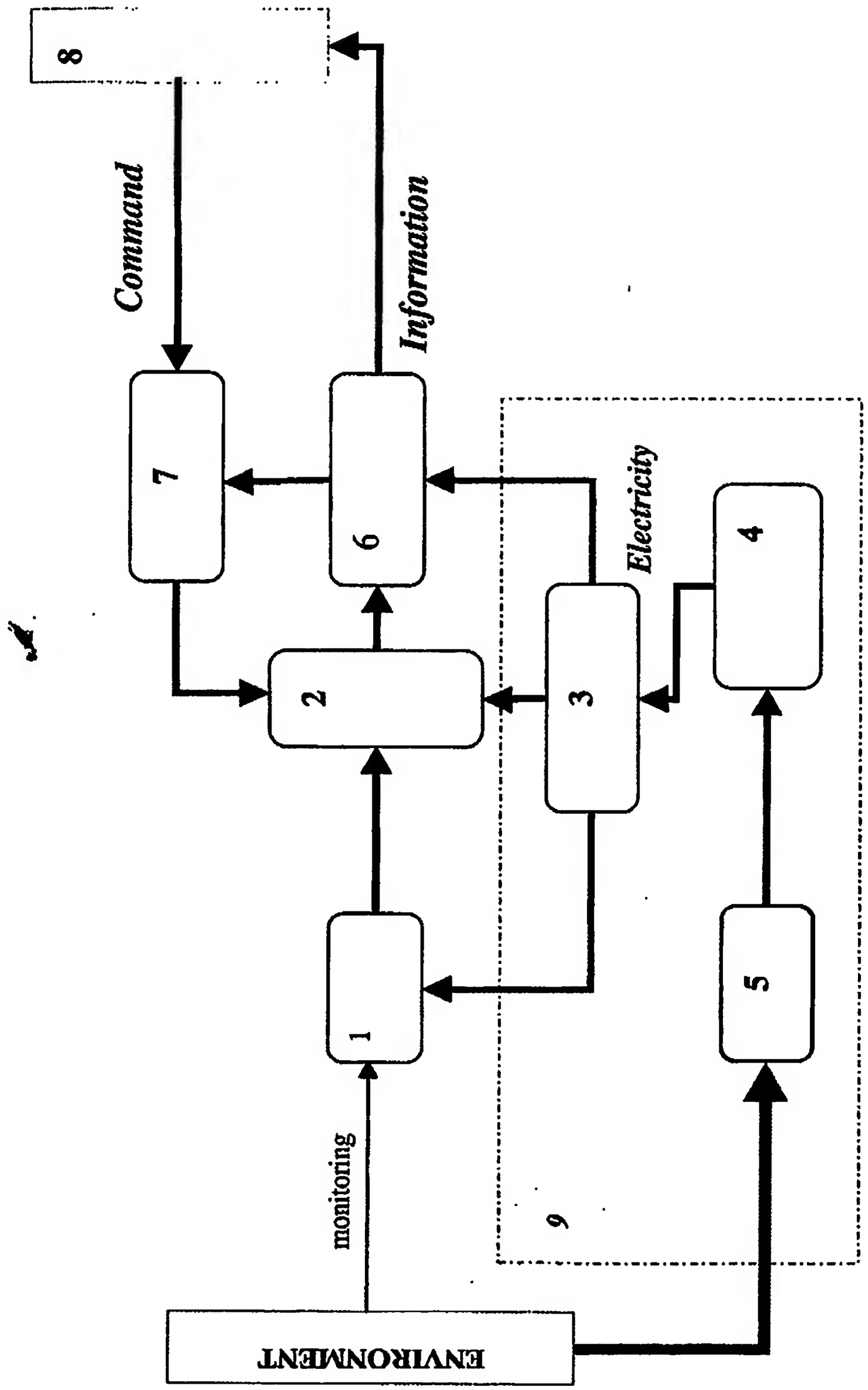
8
Command
Information
7
6
Electricity
4
2
3
5
1
monitoring
9
ENVIRONMENT

Figure 1

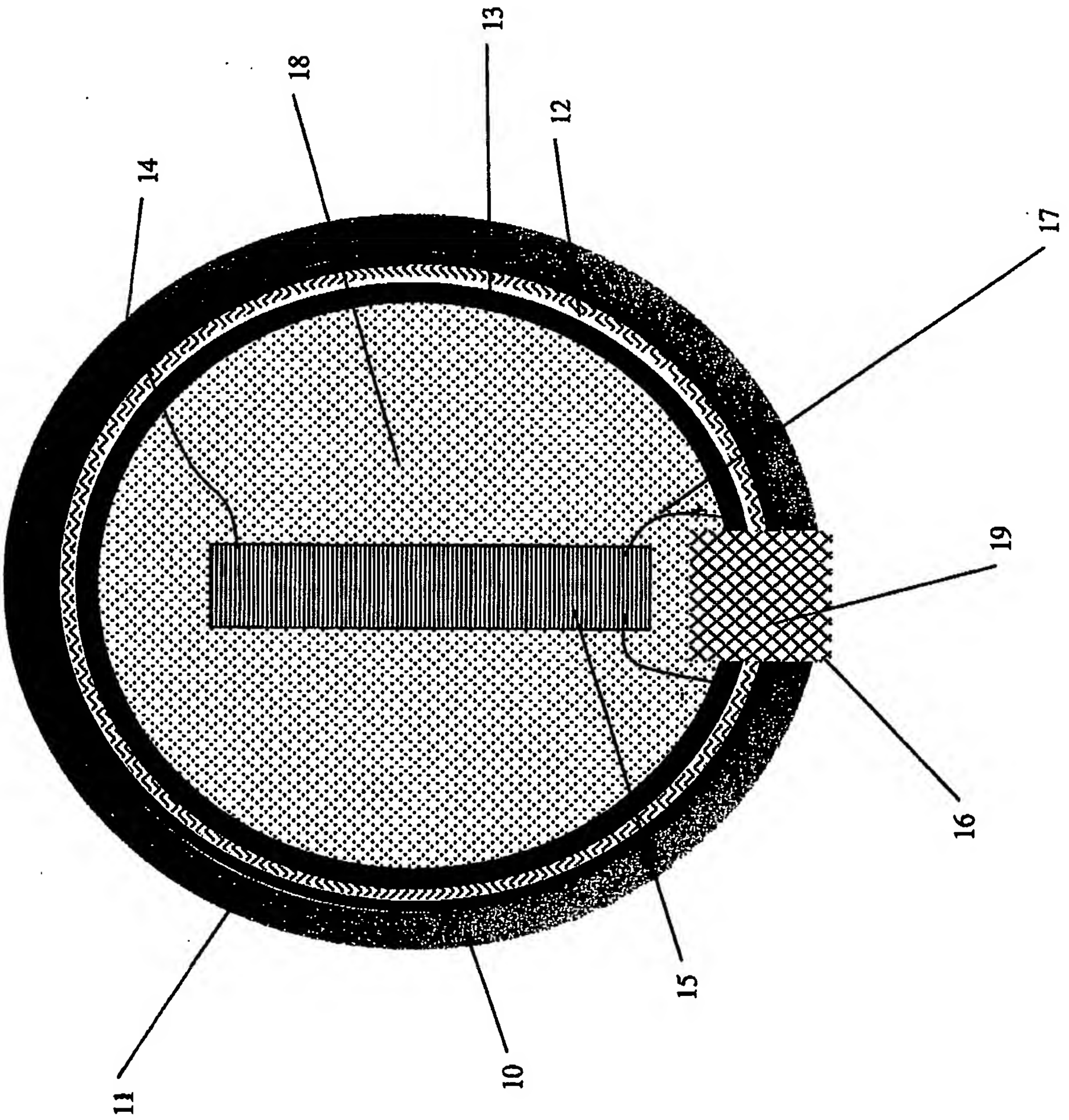

Figure 2

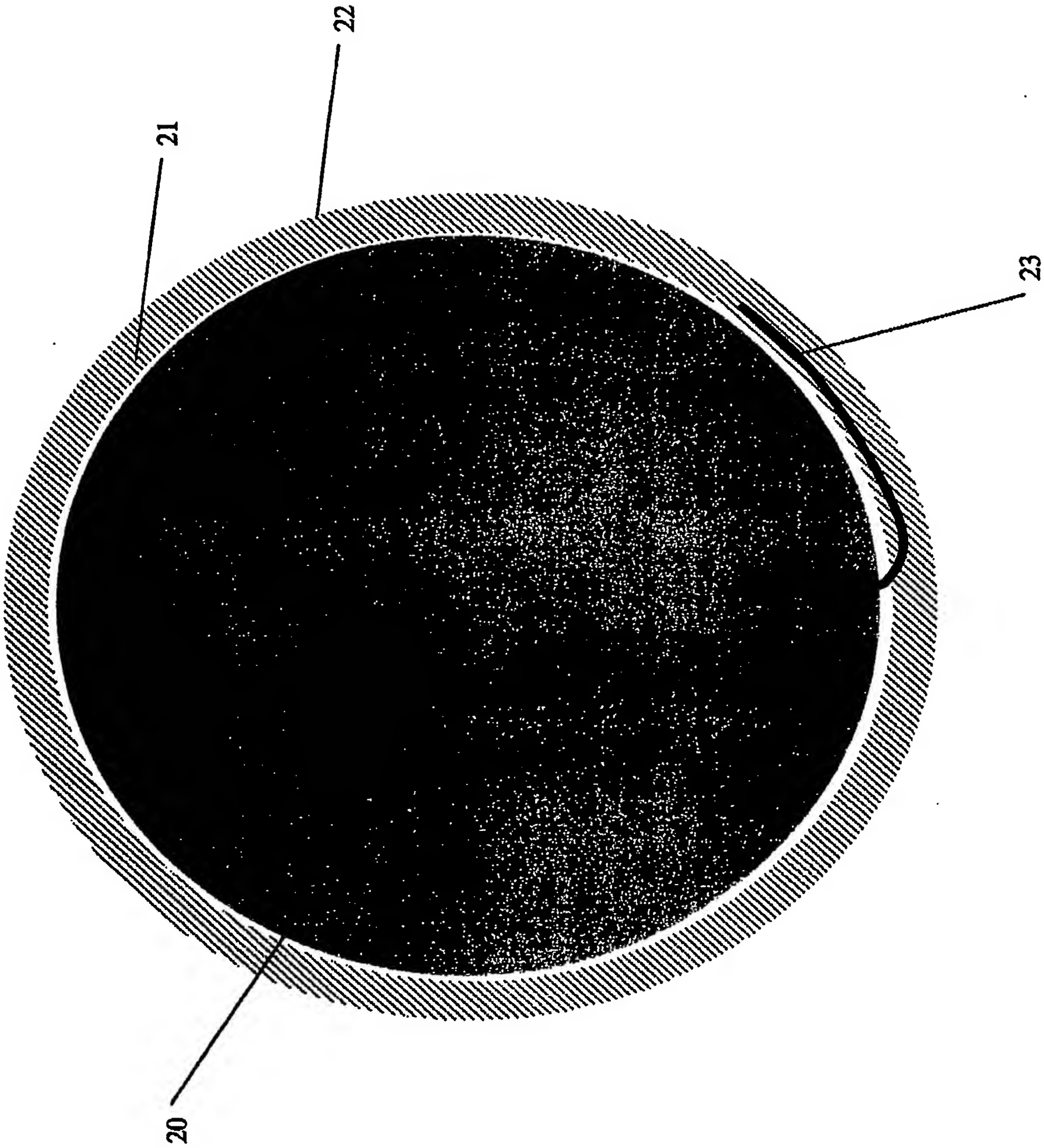

Figure 3

Document made available under the Patent Cooperation Treaty (PCT)

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